VIRTUAL REALITY AS A DESIGN EDUCATION: *A Malaysian experience*

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Abstract. This paper presents our attempts on virtual reality curriculum development for the past four years as one of the multimedia-based degrees. It will give an overview, goals and outcomes of the virtual reality (VR) curriculum with varieties of virtual reality systems, interactions and design theories used at different level of studies. It also highlights issues related to designing virtual spaces and the approach used to suggest a good storytelling. This paper will also explore, report and demonstrate the use of non-immersive virtual reality system based on a study in a problem-based learning environment of a virtual reality majoring. Following early encouraging first round results this paper concludes that experiential design could be one of the effective approaches for a problem-based learning and richer content creation of virtual environment (VE) design. It also suggests that the presence of motions, different field of views, interactivities and stereoscopic visions are attributes of three-dimensional (3D) visualization that contribute to better understanding and designing virtual environments.

Keywords. Virtual reality; design education; problem-based learning; virtual environment.

1. Introduction

While there have been a few attempts to approach virtual environment (VE) design such as learning from architecture (Bridges & Charitos, 1997; Garba, 2004; Bourdakis & Charitos, 2002) and film-related studies (Bridges & Charitos, 1997), VEs are significantly different by nature as compare to the physical environments (PEs). According to Bridges & Charitos (1997), these differences may be seen as problems due to the limitations of current virtual reality technology and intrinsic characteristics of virtual environments that can help to understand the individual nature of virtual environment as a medium. Similar to many design-based applications (Campbell & Wells, 2007), virtual reality design undergone the following phases: schematic design, design development, presentation and evaluation, detail development, prototyping, testing and evaluation, and final content output. In schematic design phase (Campbell & Wells, 2007), the overall characteristics of the virtual world are established. Significant issues are identified together with initial ideas or design decisions. In design development, the specific characters and intent of the entire project are described before progress in the presentation and evaluation stage. Proposals are presented, evaluated and commented by the target users (or clients), review board and relevant expertise, and design decisions are finalized. Following the approval of design, details are developed, prototype are tested and evaluated, revised and finally will be the content output.

Considering virtual reality as one of the most powerful tools for designers, the potentials (or problems) can only be recognised after the extensive use of the technology (Campbell & Wells, 2007), specific to all design phases. According to them, these iterative cycles not limited to

content designers but have potential uses to programmers, ergonomists and human factor professionals, engineers and interface designers for improvements and benchmarks. The goal of this paper is to explore and observe the use of virtual reality technology for virtual world design. It highlighted advantages and shortcomings that gained from student projects exploration particularly in the early stage of design to presentation and evaluation. In addition to a general observation of the use of virtual reality technology in the design processes, three issues were also evaluated:

(a) The use of virtual reality in the early design process.
(b) The effect of the level of abstraction in the 3D virtual world design to compose the space and form.
(c) The effect of the type of interface within the virtual world on the designer's ability to design.

2. Curriculum Structure

Although virtual reality (VR) is a fast-growing field, utilization of its potential within an affordable environment in the early years of education has been limited (Kalisperis et. al, 2002). Currently, the Faculty of Creative Multimedia, a design school at the Multimedia University, Cyberjaya, Malaysia is in the process of exploring the educational potential of VR that able to provide salient features of VR curriculum content. This 10-year old University, though still considered new compared to other leading design schools, has pioneered in using new media as a means of expression in design within the Asian Regions. Courses are project-based, allowing them to explore their imagination and to innovate, using new media deliveries. Students are required to acquire skills liken to professionals while at the same time possess the understanding of the processes involved in the design process. Like most design-based courses, classes are centered on projects, exercises and submissions. Apart from this, students are also required to attend classes that will improve the computer skills through computer-related subjects as well as liberal arts to help them in the theories and fundamentals. Through the use of student-centered teaching methodology combined with technology, learners are able to think and develop their own design approach using technology-based tools that will guide them throughout their design career. Graduates from this course are expected to be able to plan, execute and manage virtual reality development projects within the area of experiential design (Forlizzi & Battarbee, 2004) that focusing on visualization (e.g. architectural and products design) and entertainment (e.g. games design) design application.

2.1 FOUNDATION OF CREATIVE MULTIMEDIA

In the Foundation of Creative Multimedia, students are exposed to creativity through the principles and elements of design. Amongst the key learning outcomes are understanding of design process, problem solving, drawing as one of the communication tools, thinking skills towards a design-process, and design appreciation and perception towards objects. Students express these ideas through drawing, sketches, physical modeling, writing and photography. The learning experience is not limited to manual (analogue) representation but also covers expression and exploration through interactive multimedia, graphic software and 3D tools. More importantly, the students understand the limitations as well as the advantages of both the analogue and digital tools to produce good content design.

2.2 BETA LEVEL (YEAR ONE)

The degree of Bachelor of Multimedia (Honours) in Virtual Reality requires students to undergo three-year full time course. The learning process of Beta Level or Year One is divided into three domains. In the 1st trimester, students are exposed to elements and principles of design

mostly two-dimensional (2D) with some 3D design fundamental theories. Students will be introduced and demonstrated on issues in spatial composition especially depth cues within the scope of monoscopic images. At the end of the trimester, the students should be able to demonstrate a 2D environment (e.g. photography as the medium) guided by principles of design and visualize the environment in a 360-degree panoramic experience. This cohort of students continued in the 2nd trimester with an introduction of 3D design. This included exploration on elements of 3D design that contribute to spatial understanding namely line, plane, volume and mass, space and texture. Users at this stage must be able to navigate and allow individual experience via hotspots interaction and walkthrough. Spatial design is further developed with the presence of non-linear storytelling. At the last trimester, concentration will be given to the development of 3D virtual environment based on the physical world experience and observation (e.g. scale, texture, lighting, level of detail, and colour). A referential 3D environment design will allow the users to gain basic interaction with objects in a low level immersion through a stereoscopic projection and depth cues.

GAMMA LEVEL (YEAR TWO)

In Gamma Level or year two, students are basically introduced with the use of virtual reality in edutainment environment. At this stage, the elements of experiential design are identified and applied in the design of virtual world. This virtual world should allow the user to have intermediate to advance level such as avatar, walking, jumping, running and objects interaction with the presence of suitable soundscape. This is followed by a foundation of game theory for the next module. Students in this module are expected to design a virtual world in an immersive environment via virtual reality tools e.g. data gloves and head mounted display for interaction. Awareness on issues related to the theoretical knowledge of cyber psychology and haptic devices fundamentals will be evaluated. The last stage requires the students to create a virtual world that permits a collaborative environment and a multi-user networked. Some simple usages of augmented reality and the overall project management are expected as the design requirements and learning outcomes.

DELTA LEVEL (FINAL YEAR)

Similar to most design schools, the Delta Level or final year requires students to suggest a project (or be given a brief) to study, design (process) before finally execute the virtual world prototype (idea). Students with a successful completion of internship program will continue in the final year stage for ten weeks to come out with the idea, process and virtual world design. This will continue for another fifteen weeks that allows them to prepare for the final production and execution. Although the department allows various topics of interest, local contents are given priority due to easy access of design issues, information and expertise.

3. Methods

In order to understand these issues, seventeen students of the 2nd year of virtual reality majoring design projects were analyzed. The fourteen-week project was carried out. Typical of most student projects, the designs from the class were developed from schematic design, through design development, to presentation and evaluation. It was not intended that the project cover into detailed or final content development. All presentations are focused on non-immersive desktop virtual reality platform.

4. Procedures and apparatus

In the early stage, the design was developed primarily using 3D software tools such as 3D Studio Max and Maya based on the sketches, physical modelling and drawings. Each student was required to suggest 3 levels of outputs, level 1 (first person point of view), level 2 (the object's or user's point of view) and finally in level 3 (interaction between user and the object). All 3D Max or Maya files were exported to Virtools, a virtual reality application software that allows real-time interactions and navigations in the virtual environment. This Window-based simulation software runs on Pentium Xeon processors and NVIDIA graphic card with keyboard and mouse interaction.

A theme of 'underwater world' was given as a project brief to all students. Student had to study, identify and suggest a 10 x 10 x 10 meters volume of virtual diorama to represent the underwater world. Existing underwater environment and creatures (preferably a small scale) would be used as a precedent study in particular observation on the form, motion dynamic and other relevant qualities that associated with the environment. Three levels were required to be developed and evaluated. In level 1, concentration will be given on first-person point of view (POV). The users basically used the mouse or keyboard to pan and tilt the virtual camera at fixed position to view and experience the environment. The level of detail was further developed in Level 2 where the users were allowed to control motion at all six axes based on the 'creature's' point of view. As for level 3, students were required to design and add interaction between the character (creature) and objects within the environment based on the third-person POV. All these stages were presented and evaluated via desktop virtual reality platform (figure 1).

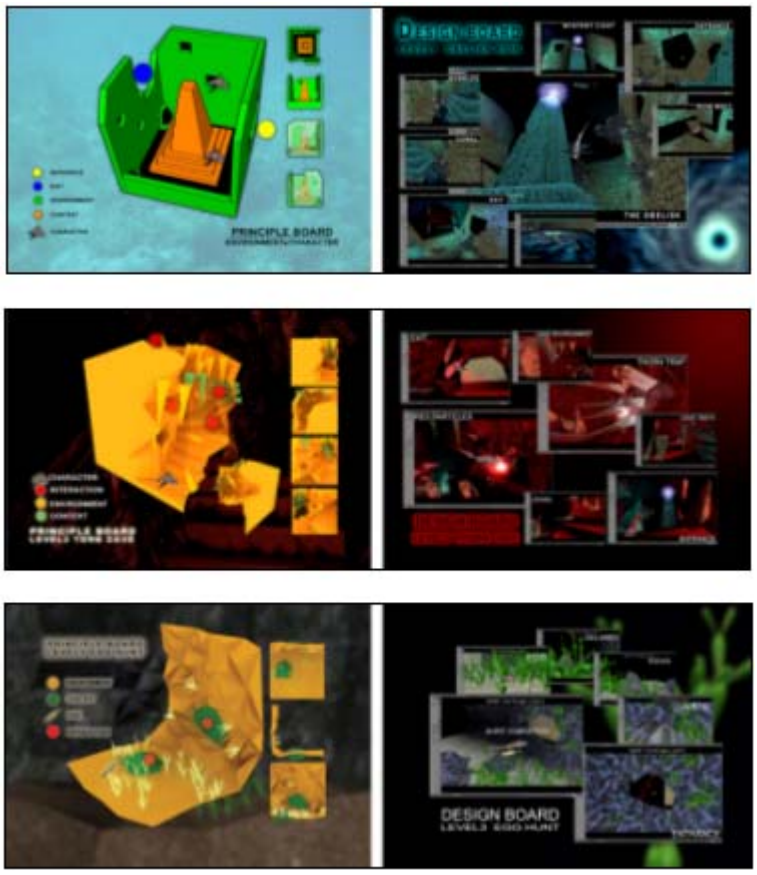

Figure 1. Computer images representing different levels of virtual world design: Level 1 (top), Level 2 (middle) and Level 3 (bottom).

5. The Design Process

5.1 Schematic design

A proof of concept demonstration was first attempted while the design was in the early schematic development. Each student was required to suggest an interactive storytelling concept within the virtual world design. This is based on the underlying elements of experiential design (Forlizzi & Battarbee, 2004) namely content, space and form, context, emotion and interaction. Most students initiated with the first element i.e. content where ideas were identified based on factors that define the story. This includes the goal, style, subject matter, intrinsic value and avatar (character). This is followed by factors that build the scene of space and form. These factors are rationalized through the exploration of the setting and topography of the scene or landscape of the virtual environment. Spatial relationships between object and space, object and object, dimension and volumetric of space, and the overall composition and interaction were developed. Other design considerations include shape, texture, tone, value and colour.

5.2 DESIGN DEVELOPMENT

The idea from the schematic design is then further developed and suggested to be position within its 'right' context. Students are required to define the level of believability and naturalism, situational target, and culture representations. At this stage, students are expected to suggest relevant emotions or factors that represent the 'mood' to the virtual world. Various feeling may be suggested to give different impact and experience within the spaces. Design that considered characters and creatures are required to portray certain level of body expression and empathy. Colour selections at this stage are critical primarily to strengthen the overall mood of the story as well as the three-point lighting principles. Scale and proportion of the character and environment were factors that also taken into account to determined students visual awareness and solutions.

5.3 DETAILED DESIGN

Detail design for virtual world concentrated more on the factors that makes the objects and environments interacts. Three domains of interaction can be considered namely fluent, cognitive and expressive. Fluent interactions are the most automatic and well-learned ones (Forlizzi & Battarbee, 2004). These types of interactions do not compete for our attention; instead they allow us to focus on the consequences of our activities. Cognitive interactions focus on the product at hand that often results in knowledge and change in the user's solution or skill. In expressive interaction, objects or users, they are suggested with certain level of relationships. In this context, these may change, modify, or even personalise the interactions in the virtual world. Apart from this, the use 3D modelling or virtual reality tools at the early stage contributed to the detailed development of the virtual world to represent a more practical solution of virtual world design, motion smoothness, texture resolution and overall interaction. Students had to develop the entire 3D virtual world model with interactive character to a convincing level of detail with different features. As for the character design, a total of 500 to 1000 polygons were established whereas for the environment a count of 2000 to 3000 polygons were sufficient.

5.4 PRESENTATION AND EVALUATION

Each student was required to present individual project that last between 15-20 minutes. These were presented using desktop virtual reality system so that progress of the development and final real-time simulation can be reviewed. Progress marking was implemented three times

with invitation of guest design critics throughout the fourteen weeks. Drawings, sketches and other form of analogue representations (e.g. 3D stills) supplement the overall presentation.

6. Discussion and conclusion

Virtual reality is a useful tool in the design process. There are issues found in the process of the problem-based learning the virtual world design:

Virtual reality in early design stage: Although virtual reality was useful for developing 3D virtual worlds it confined students to rely on a combination of sketching and 3D modeling for conceptualization stage. On contrary, the simulation tools allowed students to identify and explain spatial composition clearly due to the fact that the design complexity was easily revealed through different angles in a flexible manner. The input on the experiential design and interactive storytelling at this early stage, revealed a strong foundation on the design of the virtual world rather than a 'plain' walk-through. Students were more critical the interaction design, motion control, camera trajectory and experiential design hierarchy.

Level of abstraction: It is a fact that 2D media limit the means of representing 3D space. In this experiment, students managed to design an environment using virtual reality tools that allow immediate, direct and more intuitive control over individual design of a 3D virtual world. In fact, the real-time simulations became more useful as a design tool as the level of detail especially color, texture, geometrical complexity and lighting increased. This experiment, however, showed that students had difficulties in suggesting the right scale and proportion within the virtual world, to certain extent to balance the rendering and the frame rate consideration. Thus, it would be beneficial innovation on smart algorithms that able to simplify the overall geometry yet maintain the visual quality.

Type of virtual reality interface: Current virtual reality interfaces for non-immersive application have some limitations. Challenges of this virtual world design projects were revealed through the level of detail, motion maneuvering, a mouse-keyboard interaction and the count of polygons. Students for example, had difficulties to suggest the right scale of texture and lighting (three-point lighting) in the virtual world design. Although the level of satisfaction varies from one to another, options on a non-immersive virtual reality tool are valid to cater certain design stage and process. This may indicate that there is a need of ways to give options to visual display for aiding virtual world design.

Considering a few limitations of this research especially on the number of samples, non-immersive virtual reality tools and learning periods, this paper concludes that experiential design could be used as one of the effective approaches for designing a virtual world in a problem-based learning environment. Engaging a non-immersive virtual reality tools at the early stage of design reduced the design time particularly to understand the spatial relationship of objects and spaces, geometrical complexity, and real-time motion design for virtual world. Future reports may follow with more samples and alternatives of a low-level immersive virtual reality tool.

Acknowledgements

The authors acknowledge the staff and students of Department of Virtual Reality, Faculty of Creative Multimedia, Multimedia University (MMU) to provide and allow us to use the content. Thank you also to Dr. Ken Neo for final editing and other colleagues who always give us a good support in getting this work done.

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